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ABSTRACT

This learning packet, one in a series of eight, was developed by the Hanging Rock State Park in North Carolina for grade 5 to teach about the geology of the park. Loose-leaf pages are presented in nine sections that contain: (1) introductions to the North Carolina State Park System, the Hanging Rock State Park, the park's activity packet, and to the geology of the park; (2) a summary of the activities that includes major concepts and objectives covered; (3) pre-visit activities to provide students with a foundation in rock types and how they change over time due to weathering and erosion; (4) an on-site geo-hike to observe the parks geological formations; (5) a post-visit activity to reinforce the vocabulary words and concepts learned in the previous activities; (6) a list of 22 related vocabulary words; (7) necessary park and parental permission forms for the visit; and (8) blank pages for taking notes. Contains 12 references. (MDH)

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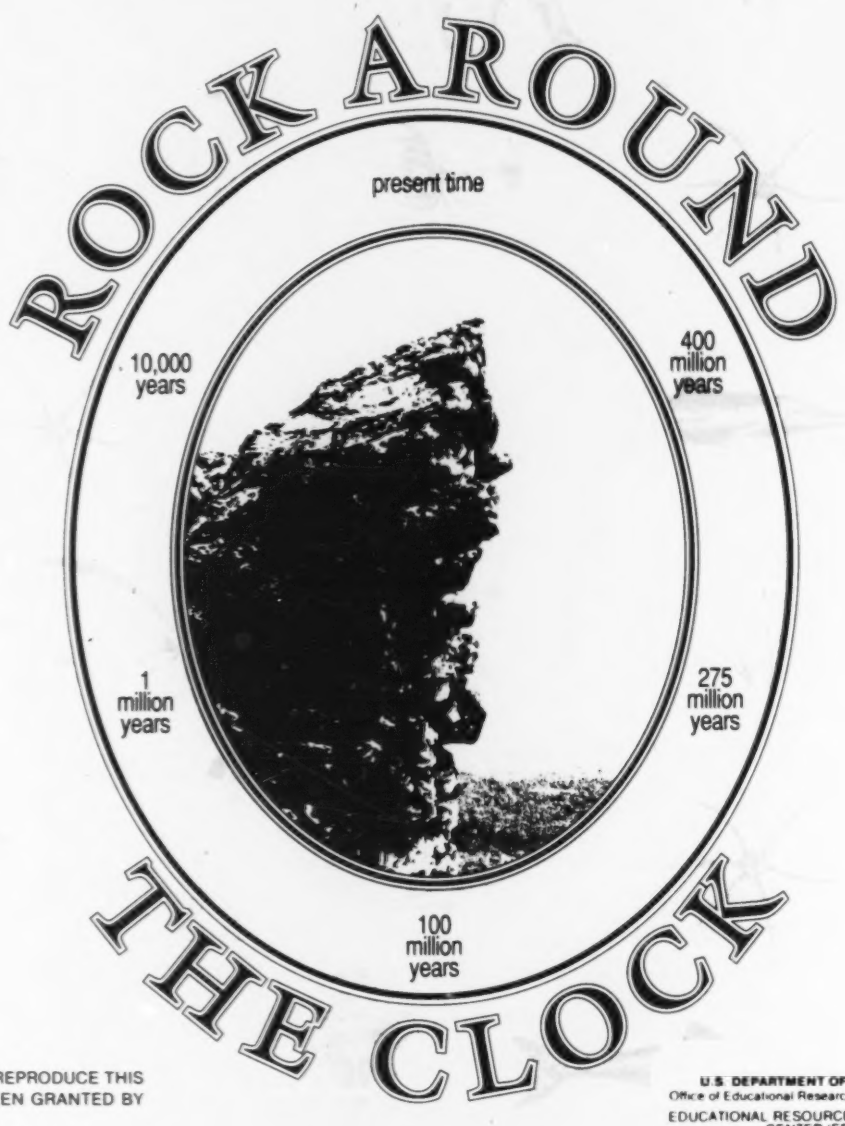

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Hanging Rock State Park

An Environmental Education Learning Experience

Designed for Grade 5

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ROCK AROUND THE CLOCK

Hanging Rock State Park

An Environmental Education Learning Experience

Designed for Grade 5

"Today's understanding of the earth's history bears little resemblance to earlier ideas. Many old theories have been revised and new theories developed. As research continues, the story of the earth's history as we presently understand it will continue to change. Every day discoveries raise new questions and result in the elimination or revision of old ideas. Much of the earth's history has yet to be deciphered and the farther back one goes in time, the less clear the evidence becomes."

Fred Beyer.
North Carolina - The Years Before Man

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CP&L

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was developed by

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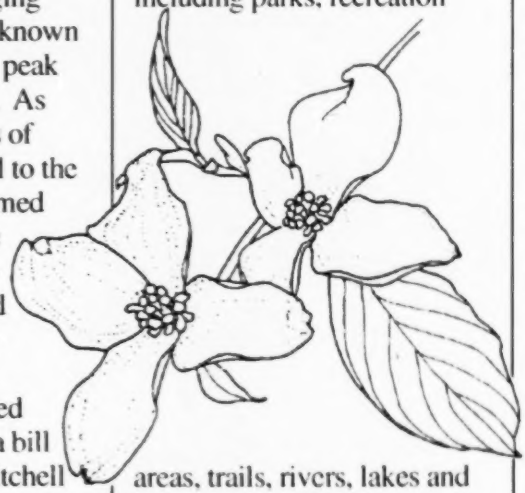
Introduction to the North Carolina State Parks System

Preserving and protecting North Carolina's natural resources is actually a relatively new idea. The seeds of the conservation movement were planted early in the 20th century when citizens were alerted to the devastation of Mount Mitchell. Logging was destroying a well-known landmark - the highest peak east of the Mississippi. As the magnificent forests of this mile-high peak fell to the lumbermen's axe, alarmed citizens began to voice their opinions. Governor Locke Craig joined them in their efforts to save Mount Mitchell. Together they convinced the legislature to pass a bill establishing Mount Mitchell as the first state park.

That was in 1915. The North Carolina State Parks System has now been established for more than three-quarters of a century. What started out as one small plot of public land has grown into 59 properties across the state, including parks, recreation



areas, trails, rivers, lakes and natural areas. This vast network of land boasts some of the most beautiful scenery in the world and offers endless recreation opportunities. But our state parks system offers much more than scenery and recreation. Our lands and waters contain unique and valuable archaeological, geological and biological resources that are important parts of our natural heritage.

As one of North Carolina's principal conservation agencies, the Division of Parks and Recreation is responsible for the more than 125,000 acres that make up our state parks system. The Division manages these resources for the safe enjoyment of the public and protects and preserves them as a part of the heritage we will pass on to generations to come.

An important component of our stewardship of these lands is education. Through our interpretation and environmental education services, the Division of Parks and Recreation strives to offer enlightening programs which lead to an understanding and appreciation of our natural resources. The goal of our environmental education program is to generate an awareness in all individuals which cultivates responsible stewardship of the earth.

For more information contact:

NC Division of Parks and Recreation
P.O. Box 27687
Raleigh, NC 27611-7687
919/ 733-4181

Introduction to Hanging Rock State Park

Hanging Rock State Park covers 6,192 acres in the Sauratown Mountains. One of the most easterly mountain ranges in the state, the Sauratown Mountains are often called "the mountains away from the mountains," because they are separated from the nearby Blue Ridge Mountains. Prominent peaks in the Sauratown range rise from 1700 feet to over 2500 feet in elevation and stand in bold contrast to the surrounding countryside which averages only 800 feet in elevation.

The Sauratown Mountains are the remnants of a once mighty range of peaks. Over millions of years, wind, water and other forces wore down the lofty peaks. What remains of these ancient mountains is due to erosion-resistant quartzite, which now supports the scenic ridges, Moore's Wall, Cook's Wall and Hanging Rock.

The park is named for one of its prominent topographical features, Hanging Rock, which offers a view across the valley of the Dan River to the Blue Ridge Mountains of North Carolina and Virginia. In addition to beautiful scenery, numerous facilities and activities make Hanging Rock one of the most popular parks in the state system.

The History of Hanging Rock

The first settlers to enter what is presently Stokes County traveled from Pennsylvania and Virginia along the "Great Wagon Road" and settled in the rich bottomland of the Town Fork Creek area. These settlements were well established prior to 1752 when Moravians entered the area and established dwellings along Town Fork Creek from the Dan River to an area west of present-day Germantown.

Two Native American tribes inhabited this area during the same period. The Saura, after whom the Sauratown Mountains were named, were a peaceful tribe dwelling in Stokes County. The Saura moved around a great deal. In the middle part of the sixteenth century they were located in the Carolina mountains. In the seventeenth century they moved to the vicinity of the Dan River where they had at least two villages. In the second decade of the eighteenth century the Sauras moved southeast and finally ended up near the Pee Dee River in South Carolina. To the west, in Surry County, early settlers encountered a hostile Cherokee tribe. Not until the end of the French and Indian War, in 1763, did the threat of tribal attacks disappear.

British troops did not appear in the Stokes County area until late in the Revolutionary War, but there were conflicts with the Tories, including one incident for which a section of the park is named. Tory's Den was so named when a group of Tories captured the daughter of a member of the Whig party who lived nearby, holding her captive in a cave in an attempt to gain aid for their cause.

In the mid-1930's considerable enthusiasm existed for the creation of a state park at Hanging Rock. The Stokes County Committee for Hanging Rock State Park, a citizens group, was founded and worked with the Winston-Salem Foundation. On April 20, 1936, the Stokes County Committee for Hanging Rock State Park deeded a gift of more than 3,000 acres in the Sauratown Mountains to the state of North Carolina.

In 1933 Franklin Roosevelt began the first relief agency, the Civilian Conservation Corps (CCC), to provide jobs through the development of public property. The CCC began work at what was to become Hanging Rock State Park in 1935. CCC activity continued in the park during the early 1940's. During this period a number of projects

were completed. In 1942, during the early days of the second World War, the CCC was abolished and work at the park slowed dramatically. Nonetheless, most of the park's goals had been attained and the park was formally opened on July 21, 1944.

Program Options:

Abounding with natural history, Hanging Rock State Park is an excellent place to teach ecology, environmental issues, biology, conservation, earth science and geology, as well as to enjoy recreation. The park is rich with cultural resources and provides a wonderful outdoor classroom for learning about the geological formation of the Sauratown Mountains and many other themes.

Groups are encouraged to visit the park during all seasons of the year for hikes, exploration, nature study and other activities. Leaders may choose to design and conduct their own activities or to use the Environmental Education Activity Packet.

Park staff will be happy to assist you with your programming needs. Please contact the park office at least two weeks in advance for arrangements.

Scheduling a Trip:

1. To make a reservation, contact the park at least two weeks in advance. Please provide the following information:

- Name of group (school).
- Name, address, work and home telephone numbers of the group contact person.
- Requested date, time of arrival and meeting place at the park.
- Departure time from the park.
- Number of participants and adult leaders. *A maximum of 30 participants is recommended. Please have one adult leader per 10 students. Adult leaders are responsible for maintaining control of the group.*
- Age range and/or special needs of participants.
- Desired activities; assistance needed from park staff.

2. Research activity permits may be required for sampling activities. If your group plans to collect any plant, animal, or mineral within the park, please contact the park office at least 30 days in advance to obtain a permit application.

3. The usual fees for activities, such as boat rental and swimming will apply.

Before You Make the Trip:

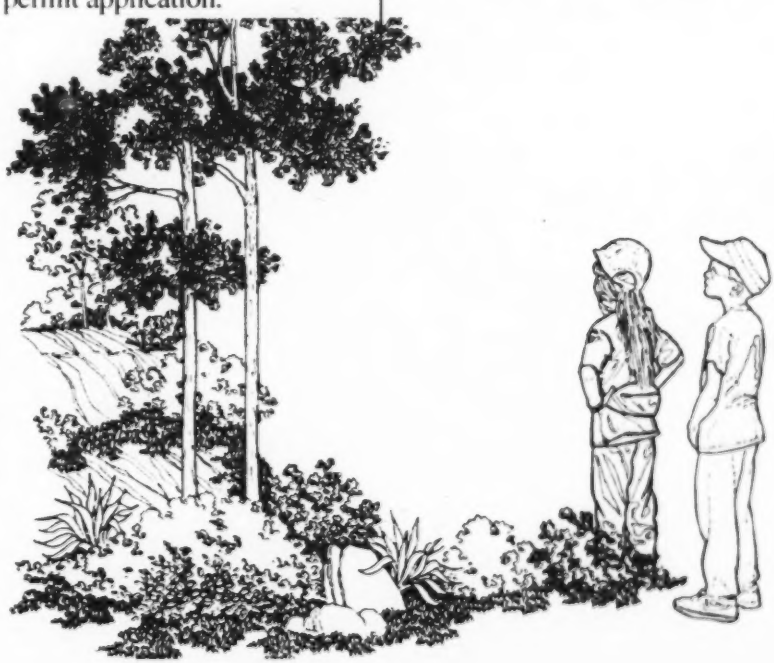
1. Visit the park without the participants prior to the group trip. This will allow you to become familiar with facilities and park staff and to identify any potential problems.

2. Group coordinators should discuss park rules and behavior expectations with adult leaders and participants. Safety should be stressed.

3. Inform the group about poison ivy, ticks, snakes and insects. Discuss the need to use insect repellent from late spring through early fall.

4. Everyone should wear a name tag. Please color-code tags (for groups) and establish a buddy system.

5. Encourage everyone to wear appropriate, comfortable clothing and walking shoes.



While at the Park:

Please obey the following rules:

1. Be as quiet as possible while in the park. This will help you get the most out of the experience, while increasing the chance of observing wildlife.

2. On hikes, walk behind the leader at all times. Trails lead to areas of cliffs and high rock ledges. Running, climbing or horseplay are not permitted. Please stay on the trails!

3. All plants and animals in the park are protected. Injuring or removing plants or animals is prohibited in all state parks. This allows future visitors to enjoy our natural resources.

4. Picnic only in the designated picnic areas. Help keep the park clean and natural by not littering and by picking up any trash left behind by others.

5. In case of an accident or emergency, contact park staff immediately.

Park Information

Address:

Hanging Rock State Park
Post Office Box 186
Danbury, NC 27016

Tel: (919) 593-8480
Mon - Fri
8:30 AM - 12:30 PM

Hours of Operation:

Nov - Feb	8:00 AM - 6:00 PM
Mar, Oct	8:00 AM - 7:00 PM
Apr, May, Sep	8:00 AM - 8:00 PM
Jun - Aug	8:00 AM - 9:00 PM

Introduction to the Activity Packet for Hanging Rock State Park

The environmental education learning experience, Rock Around the Clock, was developed to provide hands-on environmental education activities for the classroom and the outdoor setting of Hanging Rock State Park. This activity packet will acquaint your students with the basic geological process that influenced the formation of the Sauratown Mountains, of which Hanging Rock is a part. It is designed to be implemented in grade 5, and meets established curriculum objectives of the North Carolina Department of Public Instruction. Three types of activities are included:

1) pre-visit
2) on-site
3) post-visit

The on-site activity will be conducted at the park, while the pre-visit and post-visit activities are designed for the classroom environment. The pre-visit activity should be introduced prior to the park visit so that students will have the necessary background and vocabulary for the on-site activity. We encourage you to use the post-visit activity to reinforce concepts, skills and vocabulary learned in the pre-visit and on-site activities.

The environmental education learning experience, Rock Around the Clock, will expose the students to the following major concepts:

- **Rock Cycle**
- **Rock Formation**
- **Weathering & Erosion**
- **Geologic Time**
- **Geologic Process**

Vocabulary words used throughout this EELE appear in **bold type** the first time they are used in each activity. These words and their definitions are listed in the back of the activity packet. A list of the reference materials used in developing the activities follows the vocabulary list.

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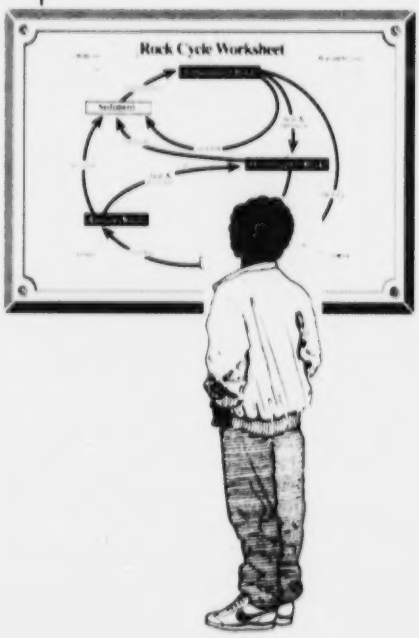
NOTE: While in the park, please remember that the purpose of the State Parks System is to preserve and protect our natural resources. Explain to students that they should not pick, injure, or destroy any plants or animals. Rocks should not be removed from the park - but should be returned to the area from which they are collected. Please stay on the trails!

The educator will assist in seeing that all safety precautions are followed. It is also the responsibility of the educator to be aware of special considerations, medical needs, etc. of participants and be prepared to take appropriate precautionary measures. Park staff should be informed of any special considerations prior to the group's arrival at the park.



Introduction to the Geology of Hanging Rock State Park

When speaking of geologic history, one must think in terms of millions of years. The earth is always changing – **rocks** are constantly being formed and destroyed; some parts of the earth are being pushed up, while others are being depressed. But as in the past, these processes are taking place very, very slowly.

At one time the rocks of the Hanging Rock area were thought to be among the oldest on earth (Pre-Cambrian). However, as the geologic study of North Carolina continues, the rocks are believed to be more recent, though still millions of years old.

At least one time in its history, Hanging Rock, like the rest of North Carolina, was covered by shallow ocean water. Hundreds of millions of years ago, the shallow **Iapetus Sea** existed in the area now occupied by the **Sauratown Mountains**. For millions of years layers of **sand** and mud were deposited into the basin from the Appalachian Mountains. From all the weight and pressure, **sedimentary rocks** were formed. Sand eventually formed sandstone and the mud formed shale. As the thickness of the layers increased (over long periods of geologic time), pressure continued to increase on the lower layers. With this pressure and heat coming from deep within the earth, the sandstone was changed into a **metamorphic rock** called **quartzite** while shale became mica schists. **Quartz** veins were probably formed by magma flows from deep within the earth injected as liquid solutions into the quartzite. After the metamorphic rocks were formed, the entire region was eventually pushed up above sea level, thus destroying the Iapetus Sea. Uplift and **erosion** went on simultaneously, continuing for thousands of years. One of the last periods of uplift was followed by a long interval of erosion with little or no uplift.

Originally the layers of rock were lying horizontally like a stack of papers; however, as the earth's surface slowly moved, the layers were gradually folded and bent. During the movement, the rocks behaved like taffy candy, bending as well as fracturing or breaking. Today these rock layers are sloping or dipping gently to the southeast. The fractures show up clearly in the cliffs of the upper ridges, the Upper Cascades, and especially well at Hidden Falls. Along these fractures, smooth-sided blocks of quartzite break out of the cliffs like building blocks.

Over millions of years, erosion has sculpted the mountains by removing the soft layers of sandstone. Sand, sandstone and mica schists were carried downstream to be deposited further into the Piedmont. The process of erosion has exposed the more resistant quartzite - thus forming the peaks, ledges and ridges of the Sauratown Mountains. Erosion continues today. Each time it rains or the wind blows, a little more of the mountains is carried away. Eventually the quartzite will wear away and these mountains will disappear ...somewhere in the far distant future of **geologic time**.

It is important to remind the students that this Environmental Education Learning Experience presents only one theory of how the Sauratown Mountains formed.

Activity Summary

The following outline provides a brief summary of each activity, the major concepts introduced and the objectives met by completion of the activity.

I. Pre-Visit Activity

#1 A Rock Solid Foundation (page 3.1.1)

This pre-visit activity, designed for the classroom, will provide the students with a foundation in rock types and how they change, as well as a concept of the length of geologic time.

Major concepts:

- Rock cycle
- Weathering
- Erosion
- Geologic time
- Geological history

Objectives:

- Name the three basic rock types and explain how they are formed.
- Name one example of each rock type found in the Sauratown Mountains.
- Explain the rock cycle.
- Give three reasons why understanding the rock cycle is important.
- Explain geologic time.
- Name the time period and era in which we live.

II. On-Site Activity

#1 A Geo-Hike (page 4.1.1)

The Geo-Hike will expose the students to the effects of geologic processes, and give them the opportunity to identify some rocks common to the area.

Major Concepts:

- Sauratown Mountain geology
- Erosion
- Weathering

Objectives:

- Name two types of rocks observed in the park.
- Identify two examples of the major rock types.
- Discuss how the geologic formations you observe were formed.

III. Post-Visit Activity

#1 Sauratown Mountain Board (page 5.1.1)

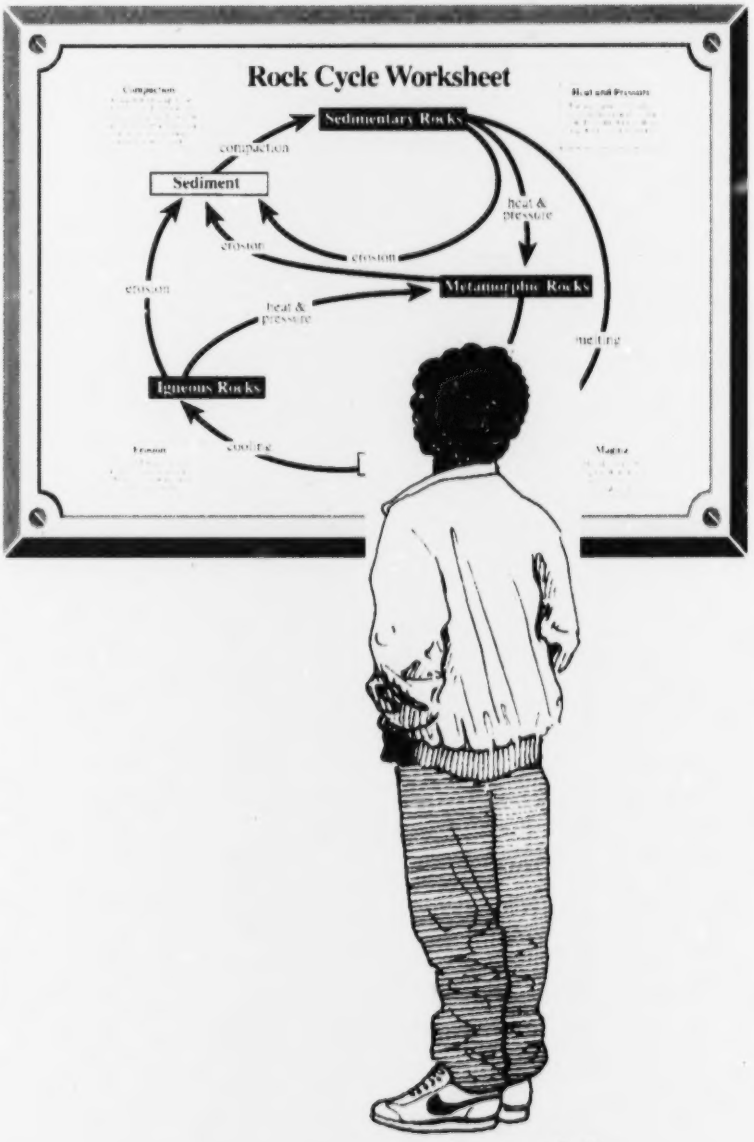
This post-visit activity will give the students the opportunity to share their new geological knowledge with others.

Major Concepts:

- Geologic processes
- Sauratown Mountains

Objectives:

- Describe at least one part of the rock cycle.
- Explain how weathering and erosion affect geologic formations.
- Describe one or more geological concepts, using text and art materials.



Pre-Visit Activity #1 — A Rock Solid Foundation

Curriculum Objectives:
Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: competency for interacting with others
- Library/Media Skills: work independently and creatively in preparing assignments
- Mathematics: solve problems in time and measurement
- Science: earth science
- Social Science: gather, organize and analyze information, participate effectively in groups

Location: Classroom

Group Size:
30 students, class size

Estimated Time:
Part A: 30 minutes
Part B: 2 - 3 class periods

Appropriate Season: Any

Materials:
Part A:
Provided by the educator:
Student's Information, Rock Cycle Worksheet (one per student)
Part B:
Provided by the educator:
A 65' long continuous strip of 24" wide paper, measuring stick, magic markers or crayons, tape, reference books on fossils and life during the various geologic time periods
Per student: "Events in Geological History" fact sheet, "Geologic Time" fact sheet

Major Concepts:
- Rock cycle
- Weathering
- Erosion
- Geologic time
- Geological history

Objectives:
- Name the three basic rock types and explain how they are formed.
- Name one example of each rock type found in the Sauratown Mountains.
- Describe the forces of erosion and weathering, and explain how these shape the land.
- Explain the rock cycle.
- Give three reasons why understanding the rock cycle is important.
- Explain geologic time.
- Name the time period and era in which we live.

Educator's Information

This activity is divided into two parts:

Part A, "Let's Get the Basics", is designed to introduce the students to the concepts covered in this activity packet.

Part B, "Time After Time", is designed to help students understand that **geologic time** is much more than minutes, hours and days. By visually comparing our existence with the formation of the **Sauratown Mountains**, the large expanse of time becomes more understandable.

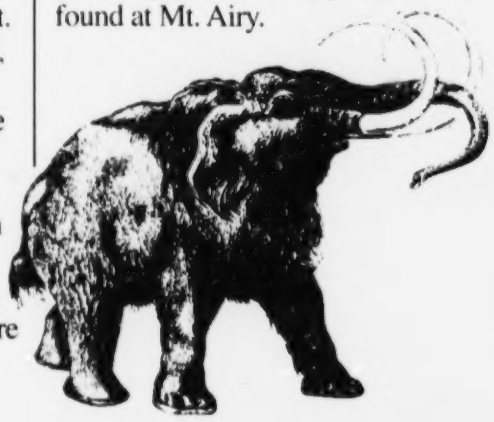
Part A: Let's Get the Basics

Instructions:

1. Use the background information on the **geology** of Hanging Rock State Park (page 1.6) to acquaint students with the Sauratown Mountains and with the concepts of **weathering** and **erosion**.

2. Distribute the Student's Information and the "Rock Cycle" worksheets. Have them read this background information.

3. Explain the worksheet to the students and discuss with them how the **rock cycle** works. Emphasize the formation of sedimentary, metamorphic and igneous rocks. Primary examples of these in the Sauratown Mountains are:
Sedimentary - **sandstone**
Metamorphic - **quartzite**
Igneous -none found in the Sauratown Mountains. The closest igneous rock is granite, found at Mt. Airy.



Student's Information:

A **rock** is an aggregate of **minerals**. Some may consist entirely of one mineral, like a diamond. Most usually consist of a few major, or essential, minerals and a number of minor, or accessory, minerals. Geologists have been able to put together a record of the earth's history by learning the process through which rocks change. All rocks fall into three classes which are named according to their origin. These classes are sedimentary, igneous and metamorphic.

Sedimentary rocks are formed as loose **sediments** wash into streams and rivers, then settle along the river's course or at the river's delta. As this **deposition** piles up over time, pressure on the bottom layers increases, compacting and cementing the layers together to eventually form sedimentary rock. An example of this type of rock is sandstone.

Sedimentary rock and metamorphosed sedimentary rock are the rock types in which fossils of plants and animals are found. Fossils are formed when plants and animals are surrounded by silt. The organic material in the plants and animals is slowly changed (chemically) to rock-type matrices. Examples of this include coal (from swamp plants) and petrified wood. Sedimentary rocks usually have a layered or bedded appearance. In fact, they may even show ripple marks or mud cracks, thus revealing the environment where they were formed.

Igneous rocks come from magmas. Magmas are molten mixtures of minerals, often rich in gasses, found deep below the earth's surface. Some kinds of igneous rock are formed when magma never reaches the earth's surface but cools slowly within it. Granite is a good example of this type of igneous rock. Another kind of igneous rock is formed when molten magma flows or spews out of a volcano or crack onto the earth's surface. Magma that comes to the surface of the earth is called lava. Lava on the earth's surface cools much faster than magma trapped beneath the surface, causing different types of rocks to form. Igneous rock never contains fossils. Temperatures which are high enough to melt rock are also plenty high enough to burn up any organic matter, plant or animal, as well as fossils.

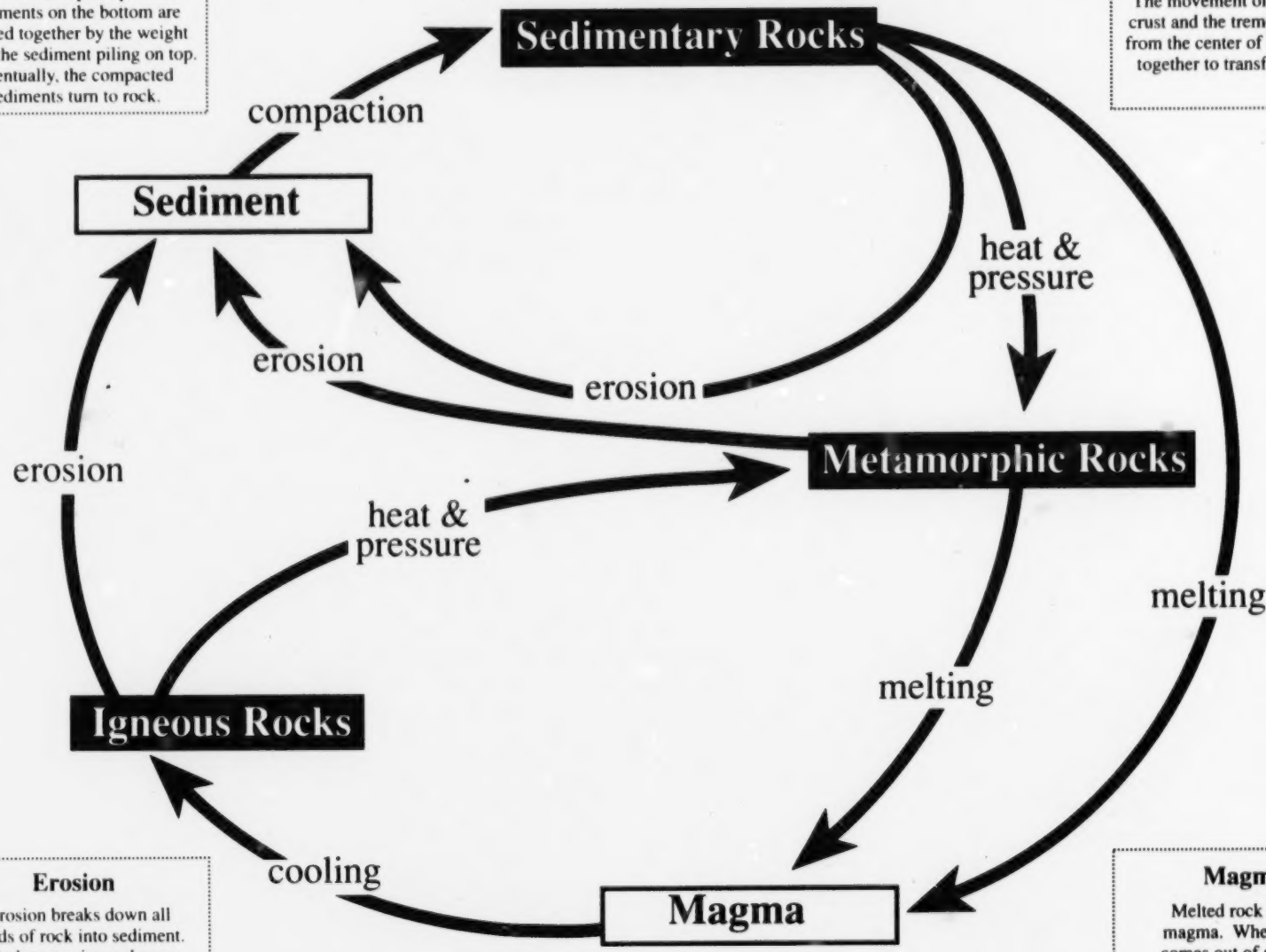
Metamorphic rocks are formed when heat and pressure change the igneous and sedimentary rocks. "Meta" means changed and "morphic" means form, so a metamorphic rock is one that has changed form. In rocks that have undergone extreme pressure, the mineral layers may be folded. An example found in the park is quartzite, which is the harder, more dense form of sandstone that has been metamorphosed.

Sedimentary, igneous and metamorphic rocks are all related to one another. Sedimentary and igneous rocks can be changed into metamorphic rock through extreme heat and pressure. Igneous and metamorphic rocks can be weathered and eroded to form sediment, that will become sedimentary rock when compressed. Likewise, metamorphic and sedimentary rocks, when subjected to extremely high temperatures, can form the constituent material of igneous rock. This relationship between the rock classes is known as the **rock cycle**.

The rock cycle is the process which makes and destroys rocks. It explains how rocks are formed, changed into other rocks, or built into mountains, through earth movement, pressure and heat. It also explains how rocks and mountains are worn away through weathering agents, particularly wind and water. This makes a complete cycle of building and tearing down.

The rock cycle is a very important geologic concept. Once you are able to identify the rocks you see and understand how they are formed, you can make educated guesses about the rocks you cannot see. These estimates will help you understand how an area was formed and predict ongoing large scale formation processes, such as earthquakes and volcanic eruptions. They will also help you determine the stability of a site as a building location, determine where water would likely be found–hence, where to dig a well– and determine where to mine for various rocks and minerals such as gold, iron, quartz and silver.

Rock Cycle Worksheet



Compaction
As sediments pile up, those sediments on the bottom are packed together by the weight of all the sediment piling on top. Eventually, the compacted sediments turn to rock.

Heat and Pressure
The movement of the earth's crust and the tremendous heat from the center of the earth act together to transform rocks.

Erosion
Erosion breaks down all kinds of rock into sediment. Wind, water, ice and snow all cause erosion.

Magma
Melted rock is called magma. When magma comes out of a volcano, it is called lava.

Part B: Time After Time

Educator's Information:

Geology is the science of the earth and its history. When we study geological history, we find that water invaded the land, layers of sediment were deposited, the land was pushed up into mountains and eventually wind, rain and ice leveled the land again. This sequence has been repeated many times over the history of the earth.

It is quite difficult for most of us to understand the concept of geologic time. Because we tend to regard events on our planet using a time scale of hours, days, months and years, it is easy to underestimate the vast amount of time covered during eras like the Precambrian.

By creating a visual model, the students should begin to more clearly understand the broad scope of geologic time.

Instructions:

1. Starting near the classroom door, run a continuous strip of paper around the room. If the circumference of the classroom is less than 65 feet, the paper can be spiraled around the room.

2. Using a yardstick and a black marker or crayon, have the students draw a continuous line, three inches up from the bottom of the paper, along the entire length of the paper. If the students will be using a marker you may want to use a test piece of the paper to assure that the marker will not "bleed through" onto the classroom wall.

3. Have the students draw another continuous line with the marker or crayon 16 inches above the first line.

4. Three inches above the line drawn in step 3, have the students make another continuous line. After steps 1 through 4, the paper should look similar to Figure A.

5. Using the magic marker or crayon, have the students place and label 390 equally spaced marks on the paper below the bottom line. (Note: each mark stands for 10 million years, giving a total representation of 3,900 million years. This works out well as the oldest rock on earth is 3,800 million years old.)

The distance between the marks should be 2 inches. (Note: when all 65 feet of the paper is used you will have a representation of 3,900 million years: 65 feet = 780 inches, divided by 2 inches gives you 390 marks, each of which represents 10,000,000 years, for a total of 3,900 million years. 3,900 million = 3.9 billion.)

The words one half million years ago (0.5 mya) and 1 through 9 mya should also be written in between 0 and 10 mya. After step 5, the paper should look like Figure B.

Figure A

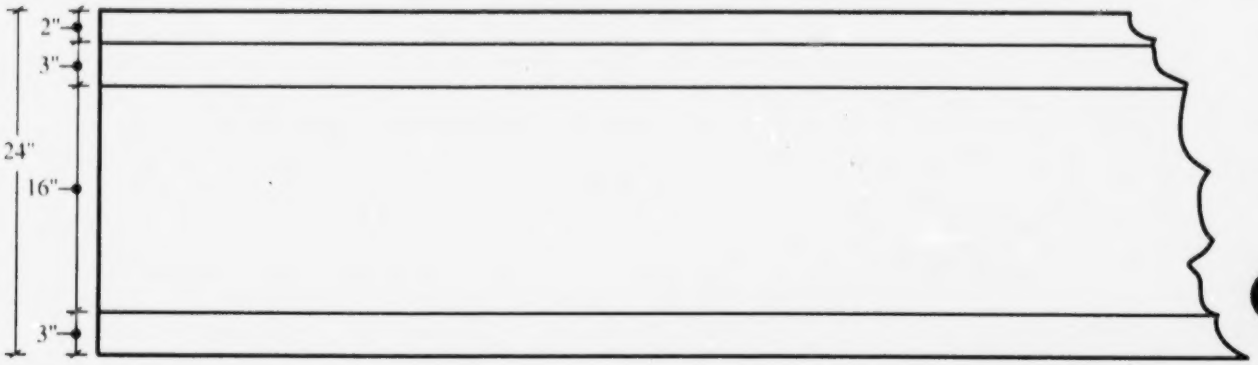
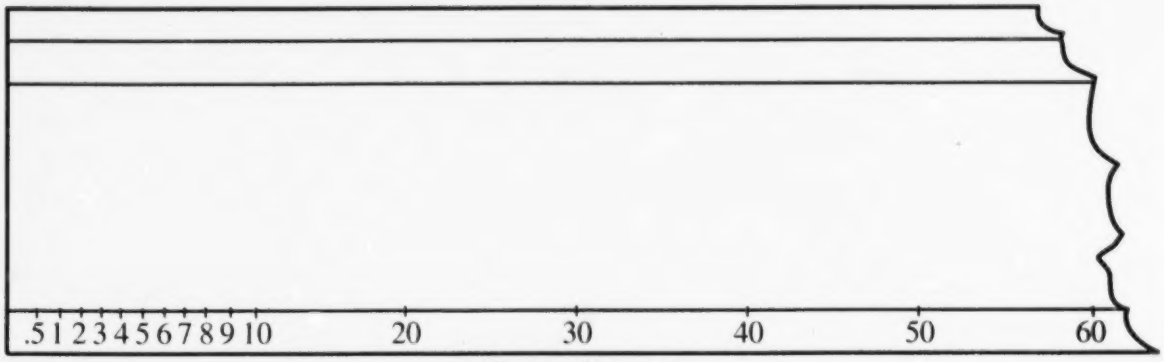


Figure B



6. This geologic time activity provides information on 16 **periods** and epochs. Divide the class into 15 teams. (This may mean that some "teams" consist of just one student.) The whole class will be responsible for depicting the Precambrian period after the other periods and epochs have been portrayed.

Each team should be assigned an epoch or period from the "Geologic Time" fact sheet. The team is responsible for finding their period or epoch on the time scale mural and marking it off with vertical lines, being sure to label the time periods (Figure C). They will illustrate what animals and plants lived during their period or epoch. For those students working within the 0 to 10 mya scale (the most recent epochs), they may not have room within these two inches to place all the illustrations. They may instead use arrows to indicate where their illustrations fit into the main scale on the paper. The students may have to do some independent research if they are not familiar with the animals and plants found in their time period or epoch. After step 6 the mural should resemble Figure D.

7. In the space remaining on the mural, fill in various events in time over the appropriate years. Events that should be depicted on the mural are: 1) when the rocks and 2) geologic formations of their area were formed. Draw pictures with markers and/or crayons to illustrate the events. Use the "Events in Geological History" fact sheet and library references as a guide.

8. After completing the timeline mural, stress that when studying geology it is often difficult to determine absolute ages. Therefore, geologists use geological **eras** and periods when discussing the earth's history rather than calendar dates. This mural illustrates the vast number of years our earth's history covers.

Figure C

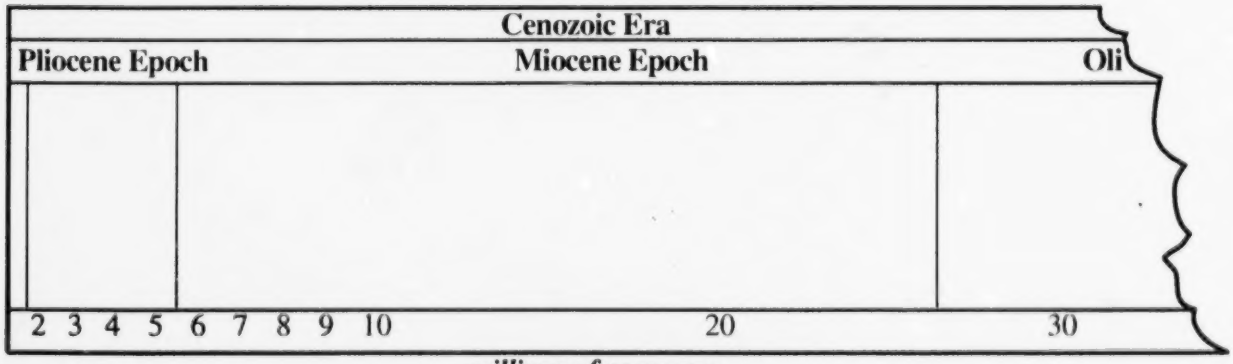
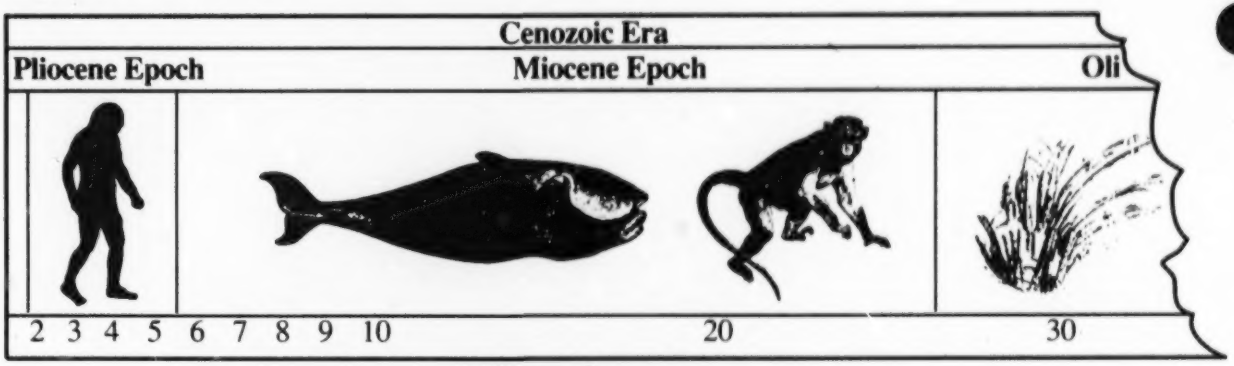


Figure D



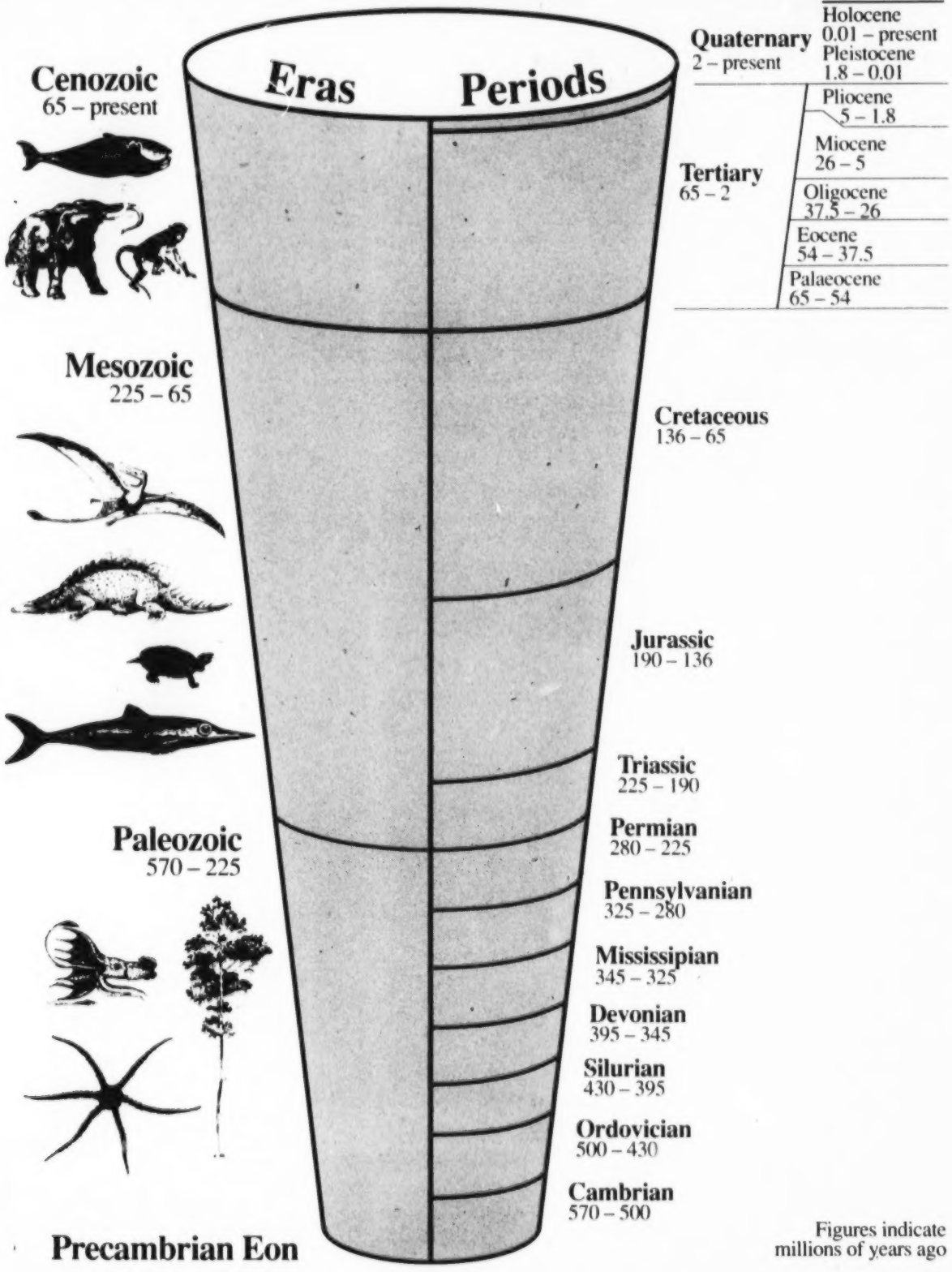
millions of years ago

9. Compare the student's life history (years of age) with the history and age of the earth and with rocks and formations of the Sauratown Mountains. Be sure to note what era and time period we live in.

Extension:

Using reference books, encyclopedias, field guides, etc., search for other earth history events not listed in the "Events In Geological History" fact sheet and include them in the mural.

Geologic Time Fact Sheet



Figures indicate millions of years ago

Geologic Time Fact Sheet

Time is an extremely important concept in geology. Geologic time includes all the time that has occurred since the formation of the earth – an estimated 4.6 billion years ago. These 4.6 billion years have been broken down into different eons, eras, periods and epochs based on the life forms that were inhabiting the earth at the time. All of time is divided into two eons: Precambrian and Phanerozoic. The Precambrian Eon lasted from the formation of the earth until the time when fossils became abundant in the rocks. The Phanerozoic Eon has been divided into three eras. Each of the eras is further subdivided into periods. Each of the periods is further subdivided into epochs. Each of the units of geologic time is characterized by different environmental conditions and specific kinds of life that flourished. Often, the boundaries between the geologic time periods was marked by mass extinctions. Scientists are using records that are preserved in rocks to put together a history of our planet.

Precambrian Eon

4.6 billion years ago to 570 million years ago

This is the longest division of earth's history, representing about 87% of the 4.6 billion years that the Earth has existed. The rocks laid down during the Precambrian Eon form the cores of today's continents. The very first, extremely simple forms of life started to evolve about 3.4 billion years ago. Life on earth began as simple, one-celled organisms, like blue-green algae. This algae used carbon dioxide and sunlight as energy sources. However, its waste product, oxygen, enabled the evolution of more complex life. Sponges, soft corals, jellyfish and annelid worms also evolved during the Precambrian Eon.

Phanerozoic Eon

570 million years ago to the present

Paleozoic Era

"Age of Ancient Life"
570 million to 225 million years ago

Cambrian Period

570 to 500 million years ago

This period marks the first appearance of fossil shells. The most common shelled animal of this time was the trilobite. Trilobites were probably scavengers on the floor of the ocean. All life lived in the ocean during this period, because the earth's atmosphere had not yet developed to protect the land from the ultraviolet radiation of the sun. Along with the trilobites, there were sponges, brachiopods and gastropods (one-shelled mollusks like whelks). At the end of the Cambrian Period there was a mass extinction of 75% of all the trilobite families, 50% of the sponge families and many of the brachiopods and gastropods. No one knows what caused this extinction.

Ordovician Period

500 to 430 million years ago

A few very primitive plants evolved to live on land during this period. However, most life forms were still evolving in the oceans. Bivalves, like clams and oysters, developed during the Ordovician Period, along with most of the other invertebrate (without a backbone) animals. Starfish, brittle stars, hard corals and crinoids were some of these invertebrates. Very primitive, jawless fishes also developed during this period. Fish are one kind of vertebrate, or animal with a backbone. There was a mass extinction at the end of this period. Many of the remaining trilobites and some of the sponges and early fish went extinct.

Silurian Period

430 to 395 million years ago

This period is marked by the development of extensive coral reefs. No new major forms of life developed during this period. All of the life that had already evolved continued to flourish with the exception

of the trilobite which continued to become rarer. There may have been millipedes and scorpions beginning to live on the land.

Devonian Period

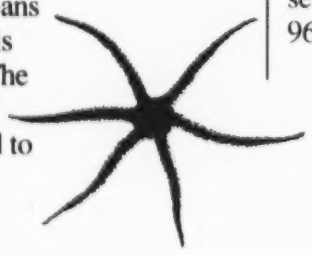
395 to 345 million years ago

This period is called the Age of Fishes because the early, primitive forms of fish really multiplied and diversified. Sharks, rays and bony fishes developed during this period. A giant, 30 foot long fish called the Dunkleosteus did not have any teeth, but the bones in its jaw were as sharp as knives. Other invertebrates began to live in fresh water during this period. The first amphibians, animals that live part of their life in water and part on land, evolved. The first forests, with giant horsetails and tree ferns, were found during the Devonian Period. The first seed-bearing plants also evolved then. Mass extinction marked the end of this period. About 25% of all species went extinct.

Mississippian Period:

345 to 325 million years ago

During this period almost all of North America was covered by oceans. Crinoids, feather stars and sea lilies flourished in the oceans during this period. The trilobites continued to decline.



Pennsylvanian Period:

325 to 280 million years ago

The 45 million years of the Pennsylvanian period was a time of mountain building and the loss of many of the shallow seas. As a result, many of the marine species declined. However, the first insects and reptiles evolved. In fact, the largest insect that ever lived, a dragonfly with a wingspan of 29", lived during this time. Most of the land was covered with swampy forests. Conifers first developed during the Pennsylvanian Period.

Permian Period:

280 to 225 million years ago

During the 55 million years of the Permian Period, the marine invertebrates specialized into many different forms. The ginko tree first appeared. Reptiles and amphibians continued to develop. One of the most important groups of reptiles from this period was the pelycosaurs. They had tall, sail-like projections from their backs that were supported by spines out of their backbone. The pelycosaur probably used its sail to help heat and cool its body. The pelycosaurs were the ancient forerunners of mammals. The Permian Period ended with the most severe of all mass extinctions– 96% of all species were lost.

Mesozoic Era:

"Time of Middle Life"

225 to 65 million years ago

Triassic Period:

225 to 193 million years ago

At the beginning of the Triassic Period, there was very little marine life left after the mass extinction that ended the Permian Period. The first modern corals developed. The entire Mesozoic Era is known as the Age of Reptiles because the reptiles developed to dominate the air, land and sea. The first dinosaurs appeared near the end of the Triassic. These dinosaurs were the saurichians which walked on two feet and had stabbing teeth. Crocodiles also appeared in the end of the Triassic Period. Lizards, turtles and marine reptiles, like the plesiosaurs, also evolved in the Triassic. Finally, the first mammal, a small mouse-like animal that ate insects, evolved. The Triassic ended with a mass extinction in which 25% of all species went extinct.

Jurassic Period:

190 to 136 million years ago

Oysters, crabs, lobsters, sea urchins and shrimps developed in the oceans. The stegosaurus and the pterosaurs, flying reptiles, appeared during this time. The mammals were still quite small, but more diverse. The Jurassic Period marks the evolution of the first bird. Insects

continued to become more diverse.

Cretaceous Period:

136 to 65 million years ago

The Cretaceous Period was one of the longest periods, lasting 70 million years. Much of the land was covered by shallow seas. Pterosaurs, the flying reptiles, became more specialized. Some of the Cretaceous Period dinosaurs include tyrannosaurs, ankylosaurs and the duck-billed dinosaurs. Flowering plants, bees and butterflies also evolved during this time. The end of the Cretaceous Period was also the end of the Mesozoic Era and was marked by a mass extinction, second only to the extinction that marked the end of the Permian Period. All of the dinosaurs went extinct, along with marine reptiles, pterosaurs, many corals, sponges and other marine invertebrates.

Cenozoic Era:

"Time of Recent Life"

65 million years to present

Tertiary Period:

65 to 2 million years ago

Paleocene Epoch:

65 to 54 million years ago

Much more dry land was exposed as the seas dried up during the Paleocene or "old recent life" epoch. The entire Tertiary Period is known as the Age of Mammals because of the development of many different kinds of mammals during the 63 million years of the period. Along with the development of hoofed mammals, rodents and squirrel-like primates on land, sharks were very abundant in the oceans.

Eocene Epoch:

54 to 38 million years ago

Eocene means the dawn of recent life. Mammals continued to diversify giving rise to whales, sea cows, bats, early horses, tapirs and rhinoceroses.

Oligocene Epoch:

38 to 26 million years ago

Oligocene means "few recent (kinds of life)." Dogs, rats, camels, cats and pigs all multiplied during this time. Sloths, armadillos and guinea pigs all evolved separately in South America.

Miocene Epoch:

26 to 5 million years ago

The "less recent" epoch lasted for 19 million years. Saber-toothed cats, elephants, apes, monkeys, giraffes and cattle are some of the mammals that evolved and multiplied during this epoch.

Pliocene Epoch:

5 to 2 million years ago

The vegetation of the Pliocene was much like today's. Australopithecines, the ancestors of humans, evolved during the Pliocene. The mammals that had evolved during the other epochs continued to multiply and spread throughout the earth.

Quaternary Period:

2 million years ago to the present

Pleistocene Epoch:

2 million to 10,000 years ago

There were at least four glacial advances during the Pleistocene Epoch, or Ice Ages. Most notably during this epoch, Homo sapiens, or humans, evolved–probably in Africa. During the Ice Ages, wooly mammoths, mastodons, and wooly rhinoceroses were common. During the warmer periods, giant ground sloths, saber-toothed cats, lions, wolves, bison, camels, cattle and horses were common. Many of the large mammals went extinct at the end of this epoch. Some scientists think that it may have been due to hunting by the early humans, but no one knows for sure.

Holocene Epoch:

10,000 years ago to the present

The climate of the present epoch is much warmer than the climate of the Ice Ages. Humans are playing a greater role in causing extinctions, particularly in the rain forest regions of the world. Many scientists feel that another ice age will likely start within a few thousand years.

Events In Geological History

Millions of Years Ago	
4000 +++	Planet formed.
4000	By now, earth has relatively stable crust with oceans and primitive atmosphere.
3800	Age of some of oldest rocks on earth's surface today.
3400	Primitive single cell life appears.
1700	Sediment is deposited in area that would later become North Carolina.
850	Iapetus Sea develops near area that would later include Stokes County.
800	Layers of sediment accumulate on Iapetus Sea floor.
570	First animals with shells appear in oceans; Cambrian Period begins.
500	Ordovician Period begins.
460	Layers of rock under Iapetus Sea are folded and bent.
440	Metamorphism of rocks forming the Sauratown Mountains occurs beneath the ancient sea floor. Land begins to rise above sea. Immediately, erosion begins and still continues today.
430	Silurian Period begins.
408	Due to movement of the earth's crust, Iapetus Sea is destroyed.
400	Plants are thriving on land above the sea; first land animals appear.
395	Devonian Period begins.
380	Insects are common.
345	Mississippian Period begins.
325	Pennsylvanian Period begins.
300	Reptiles appear.
280	True dragonflies are present; Permian Period begins.
230	Final building of Appalachian Mountains.
225	Early dinosaurs; Triassic Period begins.
208	Age of Dinosaurs.
200	First mammals.
190	Jurassic Period begins.
136	Cretaceous Period begins.
78	Modern fish appear.
70	Dinosaurs become extinct; Rocky Mountains pushed up.
65	Paleocene Epoch begins.
60	Beginning of the Age of Mammals; first hoofed mammals and primates appear.

Millions of Years Ago	
54	Eocene Epoch begins.
37.5	Oligocene Epoch begins.
26	Miocene Epoch begins.
5	Pliocene Epoch begins.
1.8	Pleistocene Epoch begins.
1	Time of Ice Ages.
100,000 yrs ago	Neanderthal man walks the earth.
40,000 yrs ago	Homo sapiens (modern man) appear.
30,000 yrs ago	People first cross over to North America.
20,000 yrs ago	Physical evolution of humans as we know them today is complete.
15,000 yrs ago	Ice sheets still cover most of North America.
11,000 yrs ago	The last glacial advance retreats; Holocene Epoch begins.
10,000 yrs ago	Groups of people in North America begin to settle down in villages.
0	Present time.

On-Site Activity #1 — A Geo-hike

Curriculum Objectives:
Grade 5
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: competency for interacting with others
- Healthful Living: recreational safety
- Science: earth science, environment
- Social Science: use maps, participate effectively in groups

Locations:
Option A -
Upper Cascade Trail
Option B -
Hanging Rock Trail

Group Size:
Approximately 30 students with a teacher, plus at least three adult assistants.

Estimated Time:
Option A -
30 minutes to 1 hour
Option B -
1 to 2 hours

Appropriate Season: Any

Materials:
Provided by the educator:
Park map

Special Considerations:
Please read the information in the Introduction to Hanging Rock State Park on "Before You Make the Trip" and "While at the Park".

Major concepts:
- Sauratown Mountain geology
- Erosion
- Weathering

Objectives:
- Name two types of rocks observed in the park.
- Identify two examples of the major rock types.
- Discuss how the geologic formations you observe were formed.

Educator's Information:

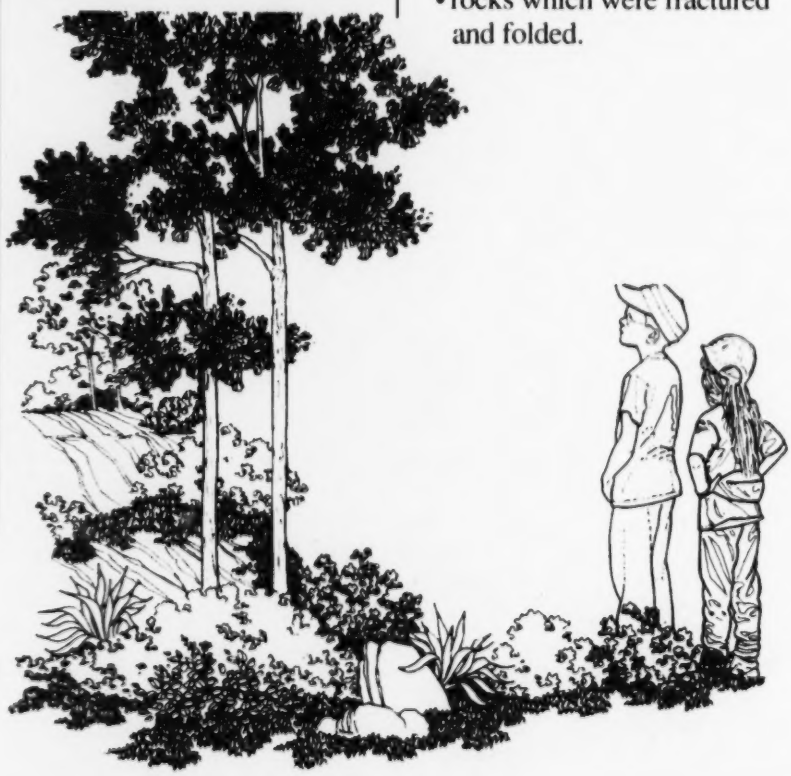
This activity is a hike to observe some of the park's geologic features.

Option A is a hike to the Upper Cascades (0.6 mile round trip). At the Upper Cascades you will be able to observe:

- water cutting through sandstone, leaving more resistant quartzite and **quartz**,
- layering in the rocks and fractures along layers, and
- rock layers tilted in their bedding.

Option B is a hike to the base of Hanging Rock (2 miles round trip). This hike is not recommended for persons who have difficulty walking. On this hike you will be able to observe:

- how the effects of weathering and erosion shaped the current landscape, and
- rocks which were fractured and folded.



Student's Information:

Option A:

Originally, the layers of rock were lying horizontally like a stack of papers; however, as the earth's crust slowly moved, the layers were gradually folded and bent. Under lots of pressure, rocks do not break, but behave like plastic. At the time of the movement, the layers were under about 8 1/2 miles of rock, and therefore under considerable pressure! During the movement, the rocks behaved something like taffy candy, bending as well as breaking and fracturing.

Today these rock layers are sloping, or dipping, gently to the southeast. Fractures show up clearly in the cliffs of the Upper Cascades. When the **quartzite** breaks off, it breaks along those fractures in smooth-sided blocks. Through the long period of time since these rocks were laid down and fractured, the softer rocks have eroded away. The **sandstone** is the softest rock, so the water eroded it, creating the gorge at the Upper Cascades. On the sides of the gorge, the more resistant rocks, quartzite and **quartz**, are seen. However, even these harder rocks are eroding, just much more slowly.

Option B:

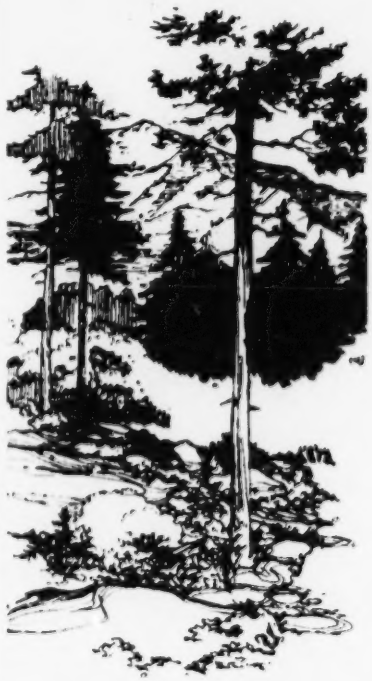
During the geologic time period that witnessed the movement and collision of the land masses, this entire region was pushed up. Rock layers were folded, bent and fractured, and large slices of rock were shoved over one another. In many places, this process resulted in older rocks being pushed up and over younger rocks.

The knife-edge ridge you walk along to get to Hanging Rock is an interesting geologic feature. This ridge is a preview of what the Hanging Rock ridge will look like in the distant future – so far in the future that it will not involve any of us.

In the past, this knife-edge ridge was a continuation of the Hanging Rock ridge and was capped with the same durable quartzite that forms Hanging Rock itself. Underlying the quartzite was sandstone, a softer rock, which weathered much more easily than the quartzite. As the valleys on each side of the ridge were cut deeper and wider, the soft rock below was weathered, undermining the quartzite top. The quartzite broke off in great blocks and boulders, each time exposing more of the softer rock.

By the continuous process of undermining and breaking off, the quartzite was gradually destroyed, leaving only this unusually steep-sided ridge as evidence of its past existence. Since the ridge is not much lower than the base of the quartzite layer that caps Hanging Rock, the knife-edge in its present form is not too old, at least not in geological terms.

On rock outcrops like Hanging Rock, **weathering** and **erosion** by wind have a major effect on shaping the land. Because the outcrop is high and exposed, the wind is a constant force, slowly eating away at the softer parts of the rock formation. Wind, like water, moves away loose sediments. In the process, the wind-blown particles strike against rocks, eroding and smoothing their surfaces by **abrasion**. The wind and water are such powerful forces of weathering and erosion that, sometime in the far distant future, the Hanging Rock quartzite will finally be worn away, and the ridge will be gone.



Instructions:

Option A:

1. Discuss with the students basic trail safety information (see Special Considerations). Remind the students that the purpose of the State Parks System is to preserve and protect our natural resources. Explain to the students that they should not pick, injure or destroy any plants or animals. Rocks should not be removed from the park, but should be returned to the area from which they are collected.

2. Before you leave on the hike give an overview of the background information and refresh the students' memory of the rock cycle (Pre-Visit Activity #1). Encourage the students to use their observation skills to determine how the gorge was formed and note any layering, fractures or tilt in the rock formations.

3. Lead the hike to the Upper Cascades.

4. Once there, be sure to discuss how the cascades were formed. Emphasize how the rocks were laid down, the uplifting process, and then the erosive force of water and its effects on the rocks, comparing the hardness of sandstone to that of quartzite and quartz.

5. Have the students search for quartz veins in the quartzite and look for any signs of layers. See if they can find fractures along these layers and observe how straight and smooth the fractures are. Have the students also look at the rocks which have fallen and encourage them to speculate on why the rocks fell and why the rocks are shaped as they are.

quartz

Option B:

1. Discuss with the students basic trail safety information (see Special Considerations). Remind the students that the purpose of the State Parks System is to preserve and protect our natural resources. Explain to the students that they should not pick, injure or destroy any plants or animals. Rocks should not be removed from the park, but should be returned to the area from which they are collected.

2. Before you leave on the hike, give an overview of the background information and refresh the students' memory of the rock cycle (Pre-Visit Activity #1). Encourage the students to use their observation skills to note the erosion which has occurred along the ridge, giving it its distinctive shape,and to note any layering, fractures or tilt in the rock formations.

3. Lead the hike to the base of Hanging Rock, stopping for brief discussions where evidence of weathering and erosion or rock formations are noticed by the students.

4. Once there, have the students compare the differences in height between the top of Hanging Rock and the ridge you are standing on. Have the students look at the rocks that have fallen for evidence of layers and for fossil ripple marks. Remind the students that quartzite is metamorphosed sandstone. Therefore the quartzite still shows the banding of the **sand** sediments as they were laid down by water, and sometimes shows marks made by the water movement over the sediments.

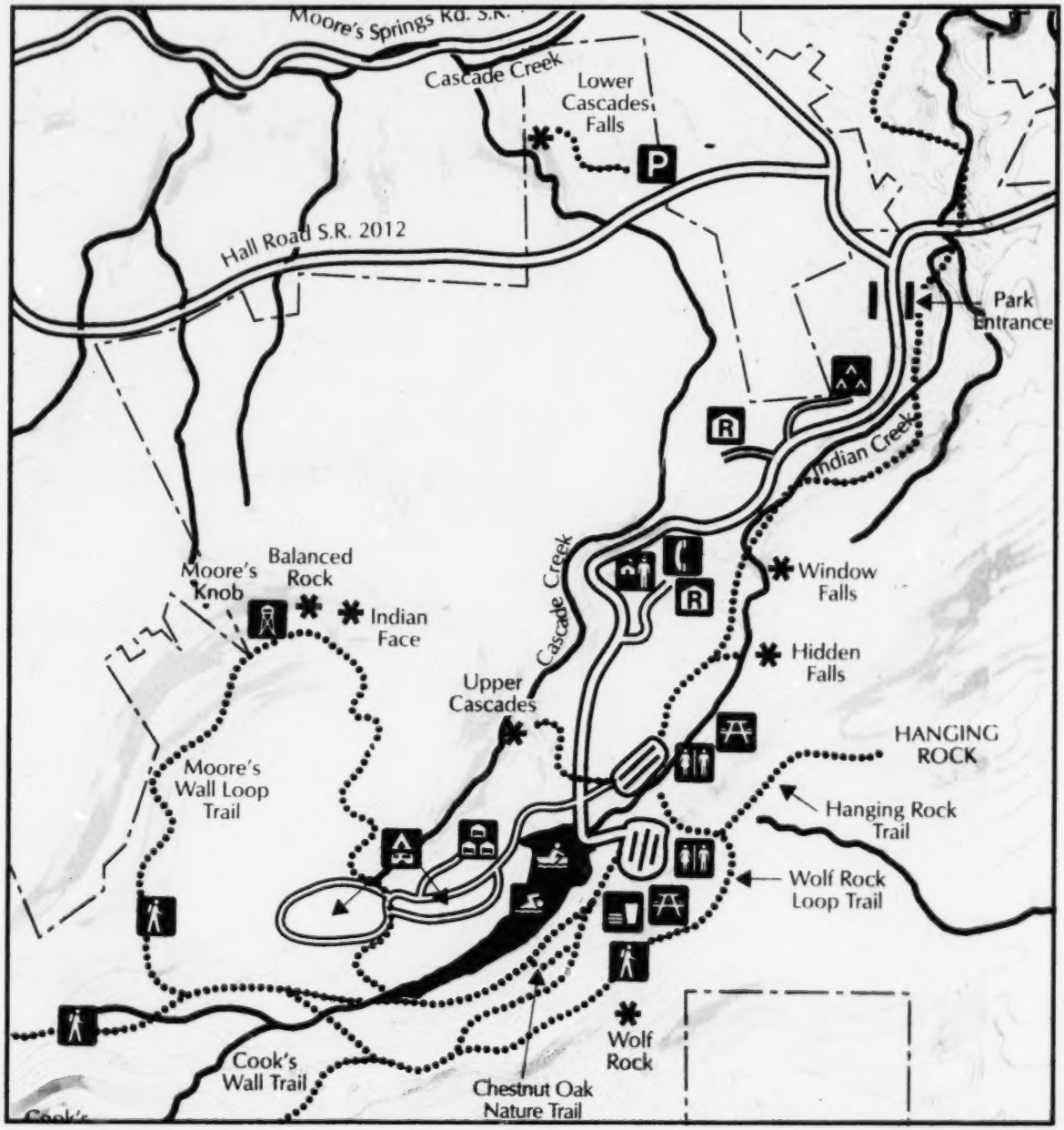
5. Remind the students that when this region was uplifted, the older quartzite rock was pushed up and over the softer, younger sandstone and in this **geologic process** the quartzite was fractured, folded and tilted. Have the students search for evidence of these fractures and folds, and see if any of the rocks appear to have broken along these fractures, showing a straight and smooth surface. Discuss with them that these fractures would have been weak spots, and with the processes of weathering and erosion constantly working on them and the softer sediments beneath, the rocks would eventually break along these weak lines. Remind the students that the rocks that make up

Hanging Rock ridge also have these fractures in them, so over the next hundreds and thousands of years, as the softer sediments below the quartzite cap erode, these rocks will eventually weather and erode to the point where they too will break off.

6. Have the students observe the weathering and erosion that have occurred. Emphasize the importance of wind here. Wind is a constant force blowing small particles at the ridge, smoothing surfaces and eroding away loose sediments.

Evidence of the wind (and the other weathering and erosion forces of freeze-thaw and water) is most obvious on the softer rock, the sandstone, which is slowly being eroded out from under the harder quartzite.

trail map (section of park map)



Post-Visit Activity #1

Sauratown Mountain Bulletin Board

Curriculum Objectives:
Grade 5

- Arts Education: develop positive attitudes towards self, others and the arts; participate in creative dramas
- Communication Skills: listening, reading, vocabulary and viewing comprehension
- Guidance: competency for interacting with others
- Library/Media Skills: work independently and creatively in preparing assignments
- Science: earth science, environment
- Social Science: gather, organize and analyze information; participate effectively in groups

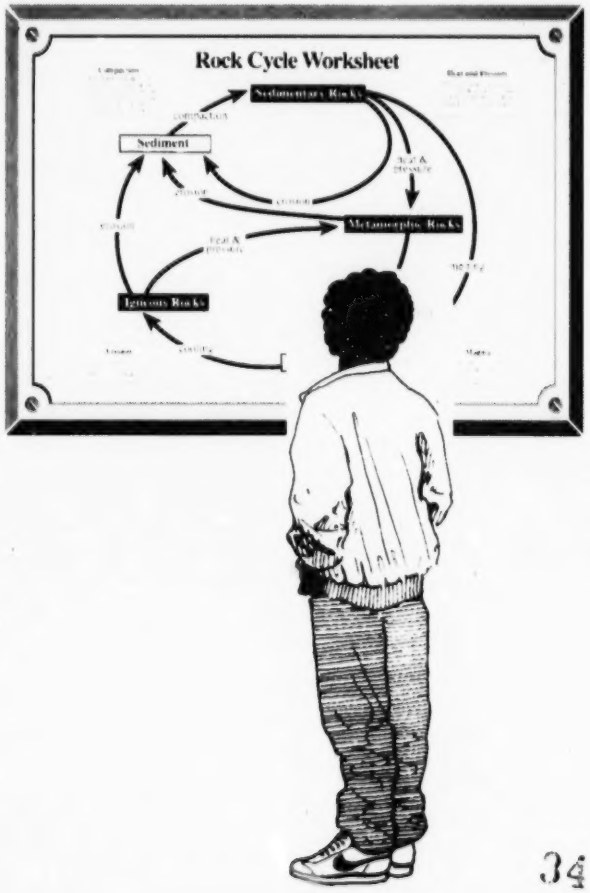
Location: School

Group size:
30 students – may want to work in small

Estimated Time: Variable

Appropriate Season: Any

Materials:
Provided by the educator:
Construction paper, markers or crayons of various colors, stapler and staples, glue, tape, scissors, bulletin board, any other art material that the students choose to use (perhaps clay, or paper mache?)



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Major Concepts:

- Geologic processes
- Sauratown Mountains

Objectives:

- Describe at least one part of the rock cycle.
- Explain how weathering and erosion affect geologic formations.
- Describe one or more geologic concepts, using text and art materials.

Educator's Information:

This activity reinforces the vocabulary and concepts learned in the previous activities

Instructions:

1. As a class, plan the bulletin board. Be sure to cover one or more of the following concepts: rock cycle, rock formation, weathering, erosion and geologic time. Also be sure to relate this to the park and to the students' experiences. Sketch it.

2. Construct. (Students may want to work in small groups and do different parts of the display.)

3. Label various points, i.e. rocks, layers, ages, etc. Arrows could be used to point out "this formed from this" to demonstrate a rock cycle.

4. Display the bulletin board where other students can see it and learn from it.

VOCABULARY

Abrasion - the process of wearing down, of rubbing away.

Deposition - term used when a mineral or sandy material settles out of water.

Era - a division of geologic time made up of one or more periods.

Erosion - the process whereby water, wind and ice loosen and carry away rock debris. This process continually wears down all rocks, creating sediments which eventually form new sedimentary rocks.

Geology - the study of the earth and its history.

Geologic process - the breaking down and building up of rocks, such as weathering, erosion, sedimentation and volcanism; the ongoing process of shaping the earth.

Geologic time - the scale used to describe the earth's history. Geologic eras and periods are used instead of years because the span of time is so long.

Iapetus Sea - shallow sea that once covered the area where the Sauratown Mountains stand today.

Igneous rock - rock formed by the cooling of molten rock on or under the surface of the earth; rock formed by volcanoes. There are no igneous rocks found in the park.

Metamorphic rock - rock formed when great heat and pressure chemically and/or physically change igneous and/or sedimentary rocks. Quartzite is an example found in the park.

Minerals - natural chemicals that make up the earth's rocks. They are inorganic and occur naturally. Each mineral has its own particular chemical make-up, as well as its characteristic crystal shape. Quartz is a common mineral found in the park.

Period - a unit of geologic time.

Quartz - a hard crystalline mineral of silicon dioxide, SiO_2, it is an important part of many sedimentary, metamorphic and igneous rocks.

Quartzite - metamorphic rock formed when heat and pressure recrystallize the sedimentary rock, sandstone. Quartzite is among the hardest and most resistant of all rocks so it is often left after wind and rain have worn away softer rocks.

Rock - a substance made up of one or many minerals. Rocks are an important part of the earth's crust, mantle and core. They come in one of three basic forms: igneous, sedimentary, metamorphic.

Rock cycle - the process where rock is repeatedly made and destroyed.

Sand - usually composed of quartz grains mixed with other bits of rock and mineral. "Sand" is actually a term used to describe the size of a small, loose particle.

Sandstone - sedimentary rock, composed primarily of quartz sand grains, formed when these sand grains were cemented together under intense pressure over millions of years.

Sauratown Mountains - the mountain range that eventually formed in the area where layers of sediment accumulated on the floor of the Iapetus Sea. Today, the range is in Stokes and Surry counties, and includes Pilot Mountain, Cook's Wall, Moore's Wall and Hanging Rock.

Sediment - term used to describe loose sand or mud.

Sedimentary rock - rock made by the compaction and/or cementing of sediments in layers. Minerals, brought in by seeping water, eventually cement the layers together. Sandstone is an example found in the park.

Weathering - in the broadest sense, any of the destructive effects that wear rocks down. Examples include heat, chemicals, wind and water; causes rocks to fragment, crack or crumble. (Erosion loosens and carries away debris caused by weathering.)

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SCHEDULING WORKSHEET

Date request received_____ Request received by_____

1) Name of group (school) _____

2) Contact person _____ _____
name phone (work) (home)

_____
address

3) Day/date/time of requested program _____

4) Program desired and program length _____

5) Meeting place _____

6) Time of arrival at park _____ Time of departure from park _____

7) Number of students _____ Age range (grade) _____

8) Number of chaperones _____

9) Areas of special emphasis _____

10) Special considerations of group (e.g. allergies, health concerns, physical limitations)_____
_____

11) Have you or your group participated in park programs before? If yes, please indicate previous programs attended: _____
_____

12) Are parental permission forms required? _____ If yes do you have these forms? _____
If not, mail contact person a Parental Permission form.

I, _____, have read the entire Environmental Education Learning Experience and understand and agree to all the conditions within it.

Return to: Hanging Rock State Park
P. O. Box 186
Danbury, North Carolina 27016

PARENTAL PERMISSION FORM

Dear Parent:

Your child will soon be involved in an exciting learning adventure - an environmental education experience at Hanging Rock State Park. Studies have shown that such "hands-on" learning programs improve children's attitudes and performance in a broad range of school subjects.

In order to make your child's visit to "nature's classroom" as safe as possible we ask that you provide the following information and sign at the bottom. Please note that insects, poison ivy and other potential risks are a natural part of any outdoor setting. We advise that children bring appropriate clothing (long pants, rain gear, sturdy shoes) for their planned activities.

Child's name _____

Does your child:

- Have an allergy to bee stings or insect bites?_____
  If so, please have them bring their medication and stress that they, or the group leader, be able to administer it.

- Have other allergies? _____

- Have any other health problems we should be aware of?_____
  _____

- In case of an emergency, I give permission for my child to be treated by the attending physician. I understand that I will be notified as soon as possible.

_____ _____
Parent's signature date

Parent's name _____ Home phone _____
(please print) Work phone _____

Family Physician's name _____ phone _____

Alternate Emergency Contact

Name_____ phone _____

NORTH CAROLINA PARKS & RECREATION
PROGRAM EVALUATION

Please take a few moments to evaluate the program(s) you received. This will help us improve our service to you in the future.

1. Program title(s) _____ Date _____
   Program leader(s) _____

2. What part of the program(s) did you find the most interesting and useful? _____
   _____

3. What part(s) did you find the least interesting and useful? _____
   _____

4. What can we do to improve the program(s)? _____
   _____
   _____

5. General comments _____
   _____
   _____
   _____

LEADERS OF SCHOOL GROUPS AND OTHER ORGANIZED YOUTH GROUPS
PLEASE ANSWER THESE ADDITIONAL QUESTIONS:

6. Group (school) name _____

7. Did the program(s) meet the stated objectives or curriculum needs? _____
   If not, why? _____
   _____

Please return the completed form to park staff. Thank you.

Hanging Rock State Park
P. O. Box 186
Danbury, North Carolina 27016

Notes

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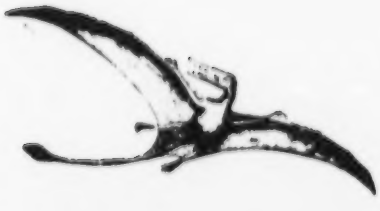

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